

GLOBAL PRECIPITATION MEASUREMENT PRECIPITATION PROCESSING SYSTEM

**File Specification
1BGMI**

Preliminary Version

March 18, 2014

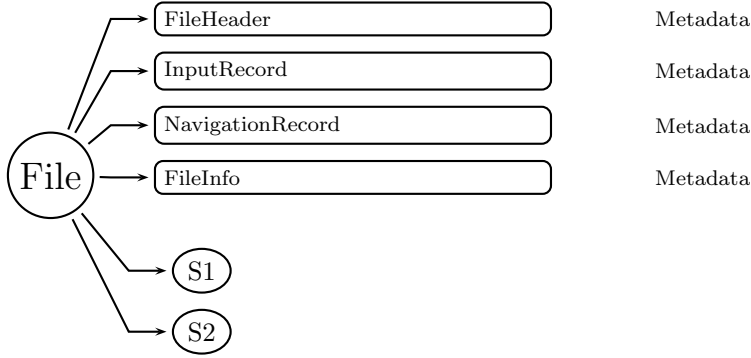


Figure 1: Data Format Structure for 1BGMI, GMI Brightness Temperatures

0.1 1BGMI - GMI Brightness Temperatures

The Level-1B GMI Product, 1BGMI, "GMI Brightness Temperatures," is written as a multi-Swath Structure. Swath S1 has channels 1-9: 10V 10H 19V 19H 23V 37V 37H 89V 89H. Swath S2 has channels 10-13: 166V 166H 183+/-3V 183+/-8V. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan1	9	Number of channels in Swath 1.
nchan2	4	Number of channels in Swath 2.
npix1	221	Number of pixels in Swath 1.
npix2	221	Number of pixels in Swath 2.
ncolds1	51	Maximum number of cold samples in Swath 1.
ncolds2	51	Maximum number of cold samples in Swath 2.
nhots1	33	Maximum number of hot samples in Swath 1.
nhots2	33	Maximum number of hot samples in Swath 2.
ntherm	11	Number of hot load thermisters.
LNL	2	Linear and non-linear.
nsamt	4	Number of sample types. The types are: total science GSDR, earth-view, hot load, cold sky.
ntach	32	Number of tachometer readings.
GMIxyz	3	x, y, z components in GMI instrument coordinate system.

Figure 1 through Figure 17 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

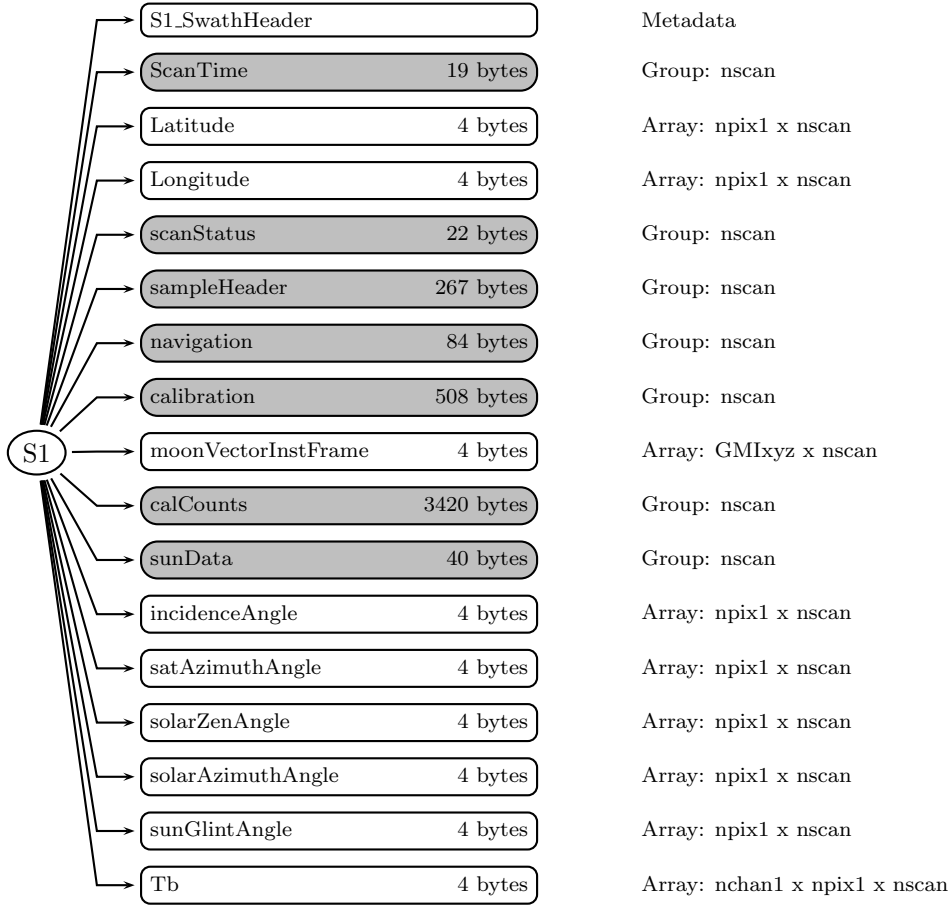


Figure 2: Data Format Structure for 1BGMI, S1

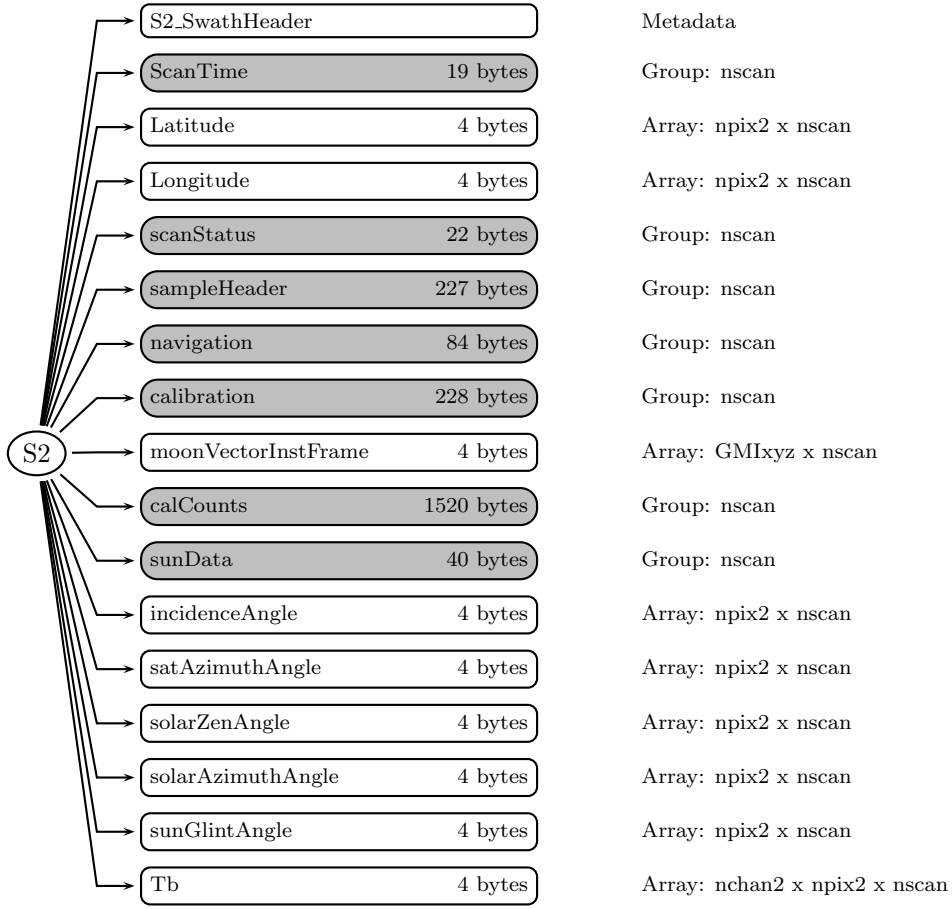


Figure 3: Data Format Structure for 1BGMI, S2

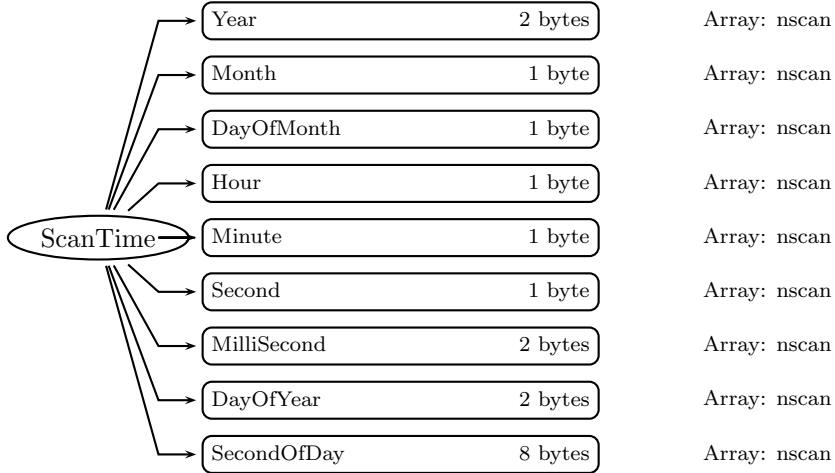


Figure 4: Data Format Structure for 1BGMI, S1, ScanTime

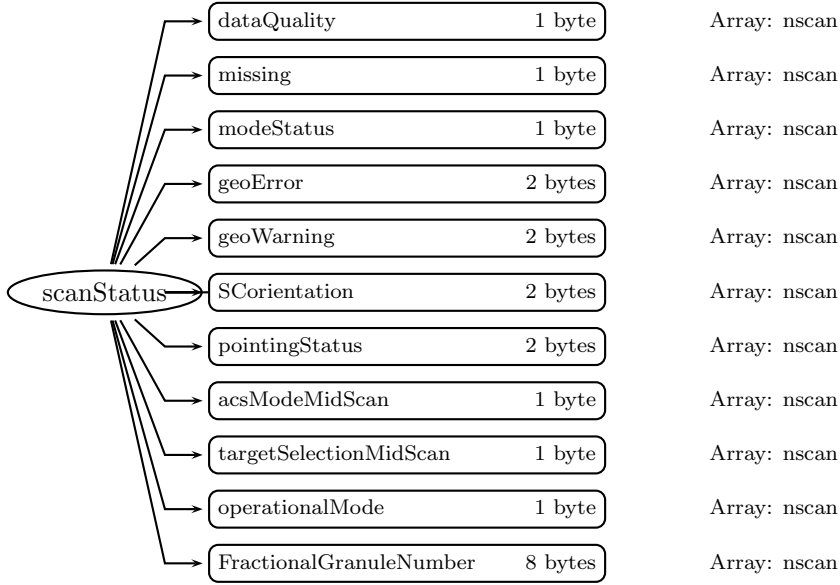


Figure 5: Data Format Structure for 1BGMI, S1, scanStatus

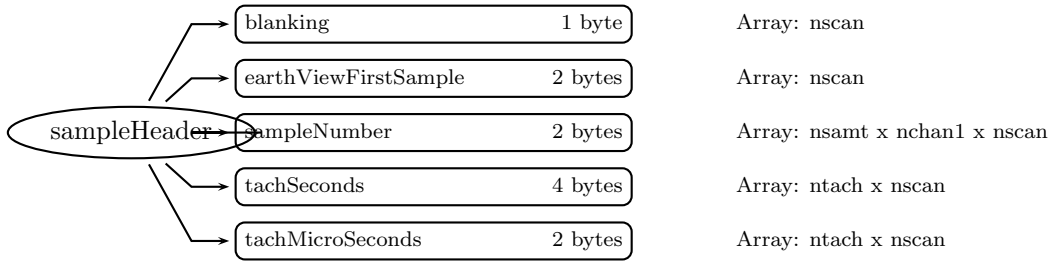


Figure 6: Data Format Structure for 1BGMI, S1, sampleHeader

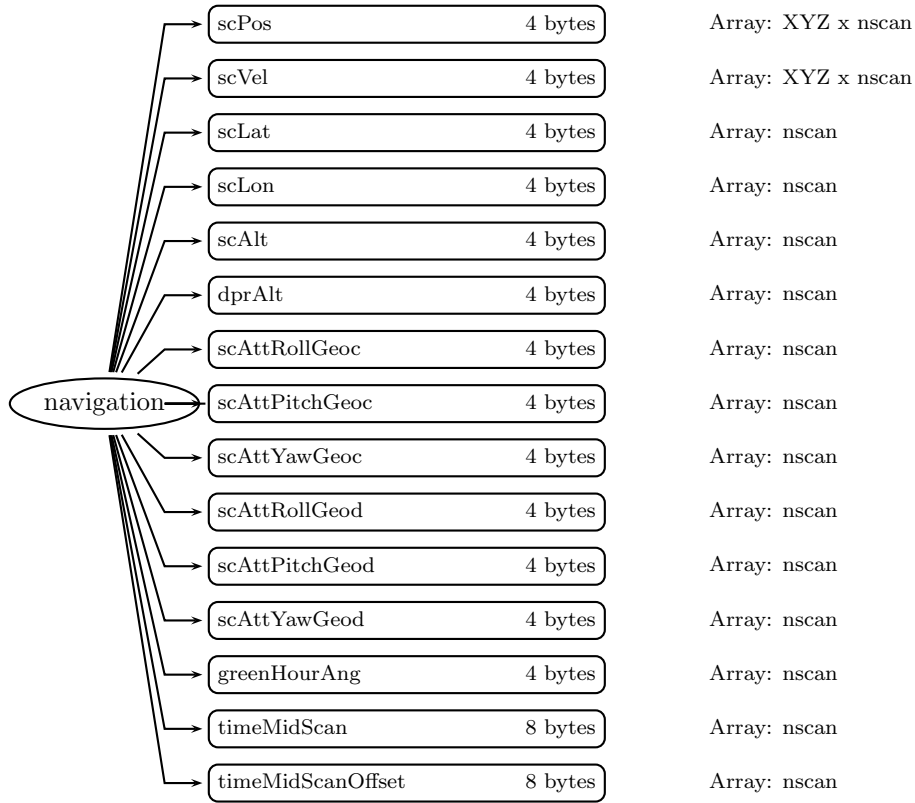


Figure 7: Data Format Structure for 1BGMI, S1, navigation

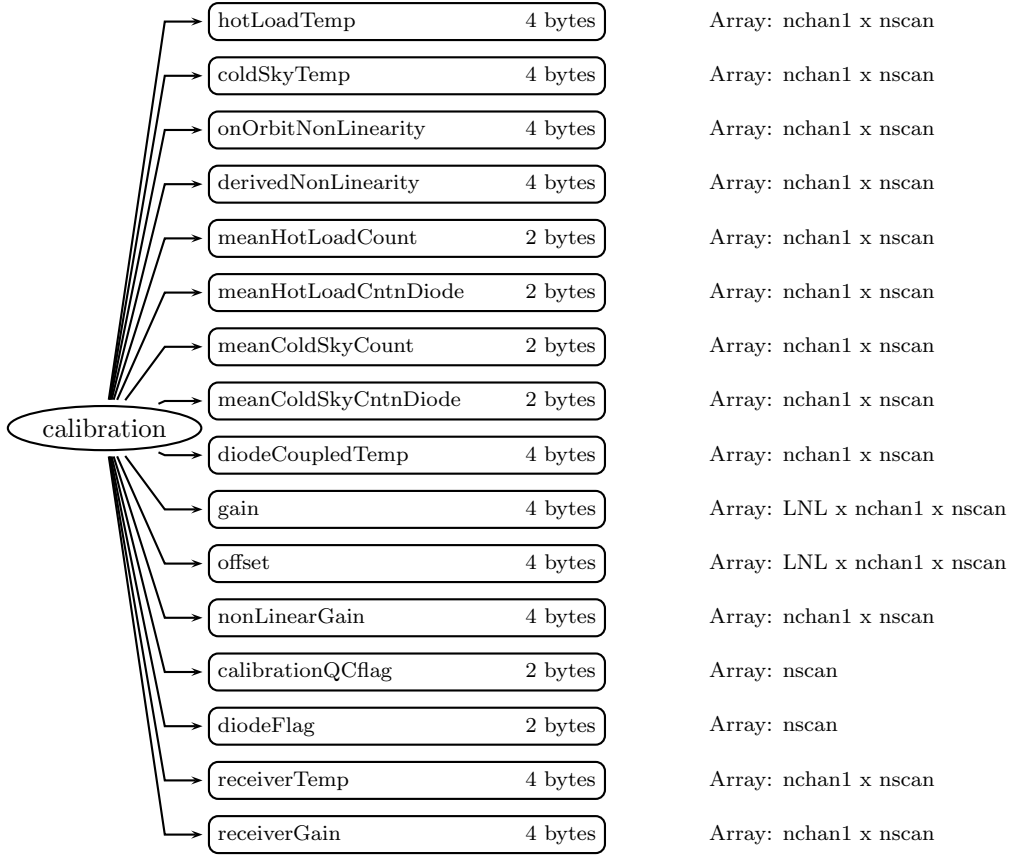


Figure 8: Data Format Structure for 1BGMI, S1, calibration

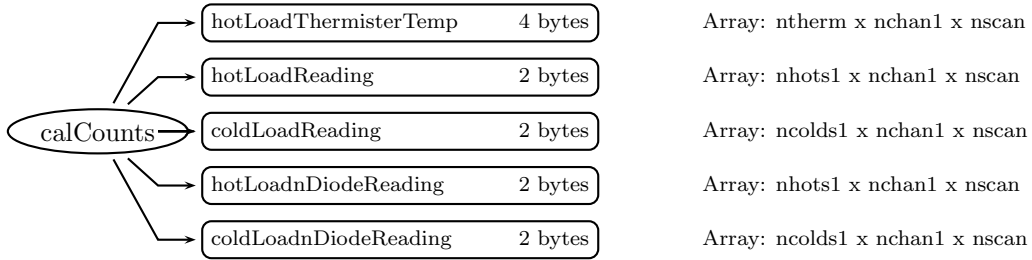


Figure 9: Data Format Structure for 1BGMI, S1, calCounts

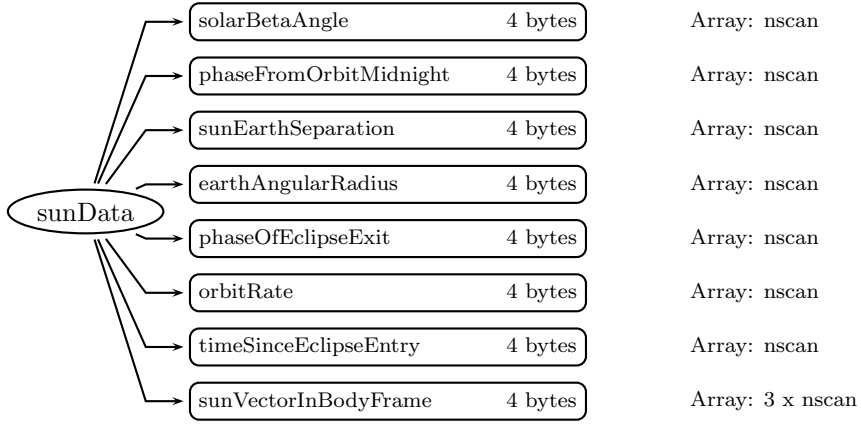


Figure 10: Data Format Structure for 1BGMI, S1, sunData

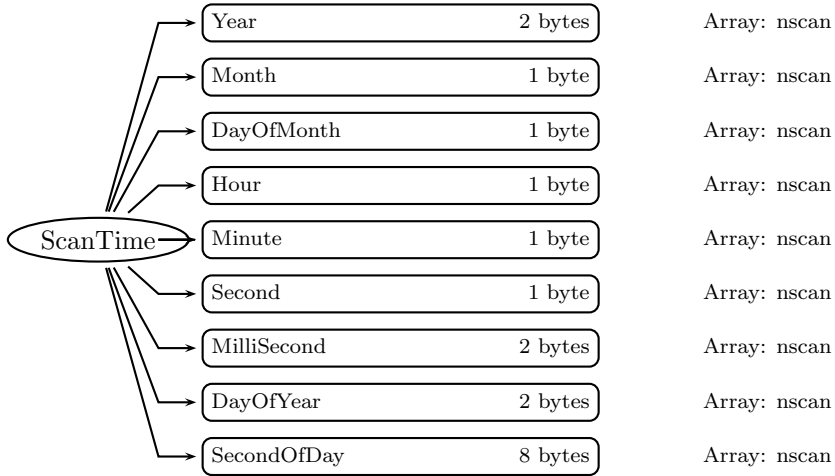


Figure 11: Data Format Structure for 1BGMI, S2, ScanTime

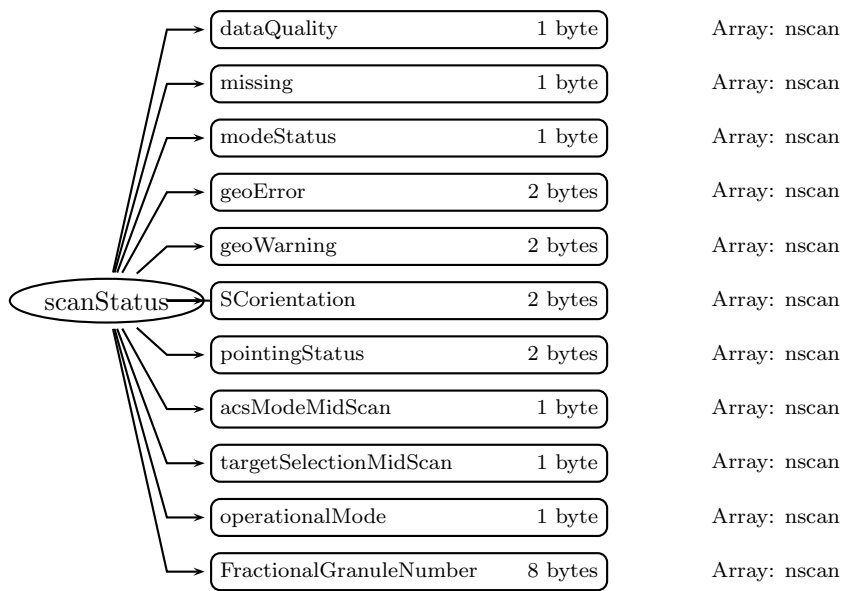


Figure 12: Data Format Structure for 1BGMI, S2, scanStatus

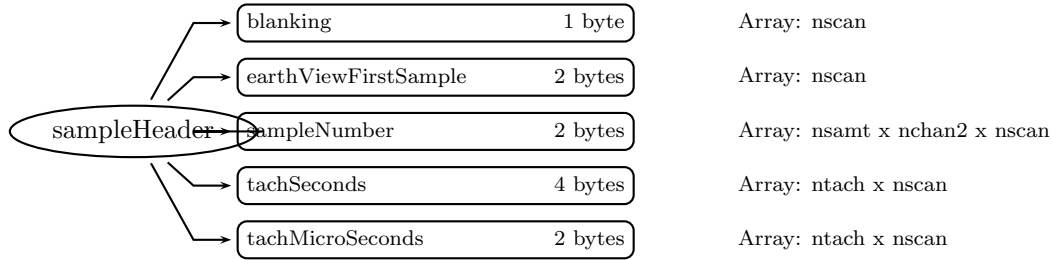


Figure 13: Data Format Structure for 1BGMI, S2, sampleHeader

FileHeader (Metadata):

FileHeader contains general metadata. This group appears in all data products. See Metadata for GPM Products for details.

InputRecord (Metadata):

InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for GPM Products for details.

NavigationRecord (Metadata):

NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

FileInfo (Metadata):

FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for GPM Products for details.

S1 (Swath)

S1.SwathHeader (Metadata):

SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan):

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

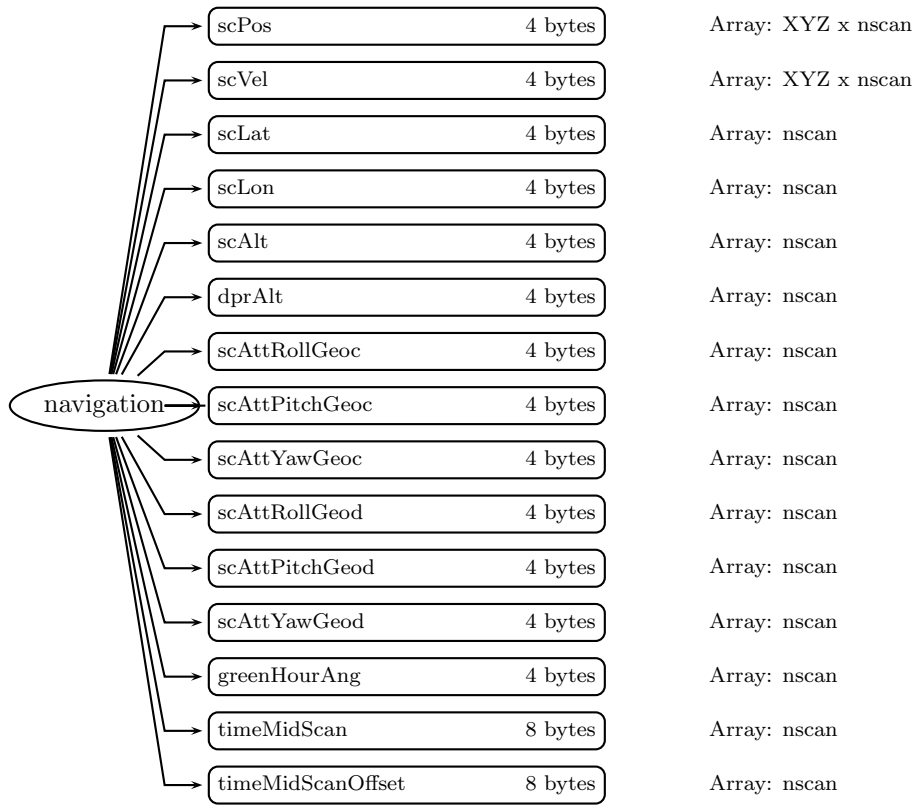


Figure 14: Data Format Structure for 1BGMI, S2, navigation

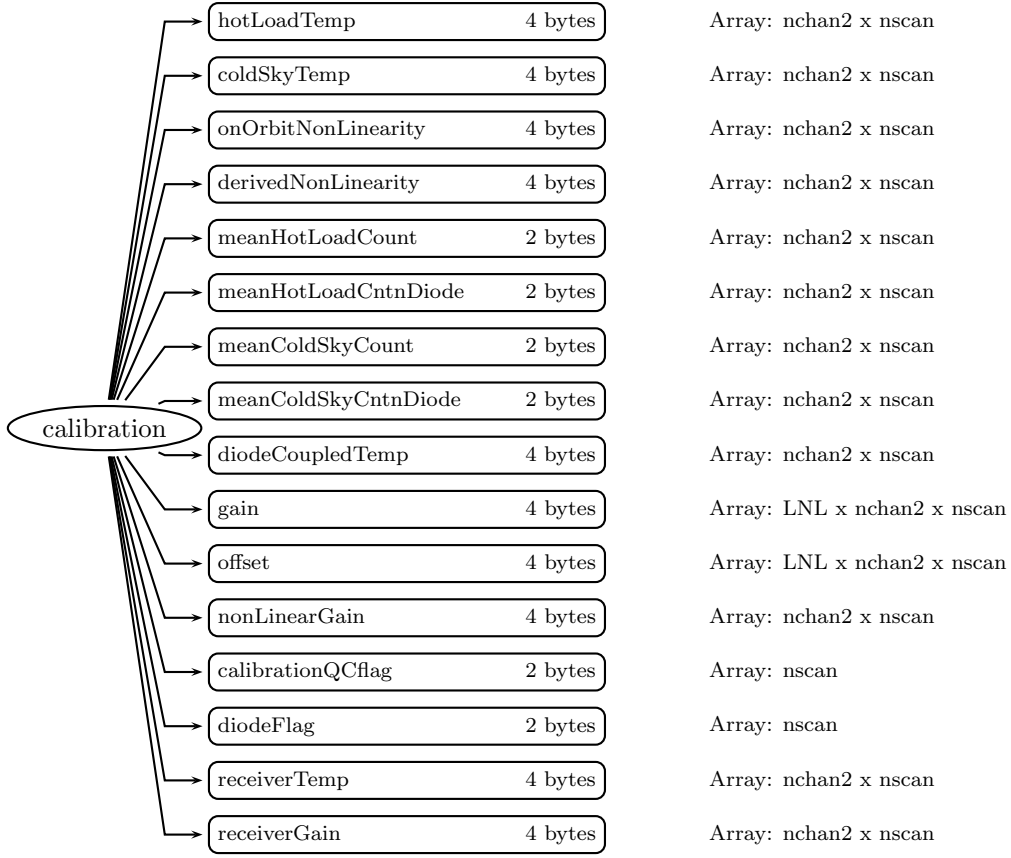


Figure 15: Data Format Structure for 1BGMI, S2, calibration

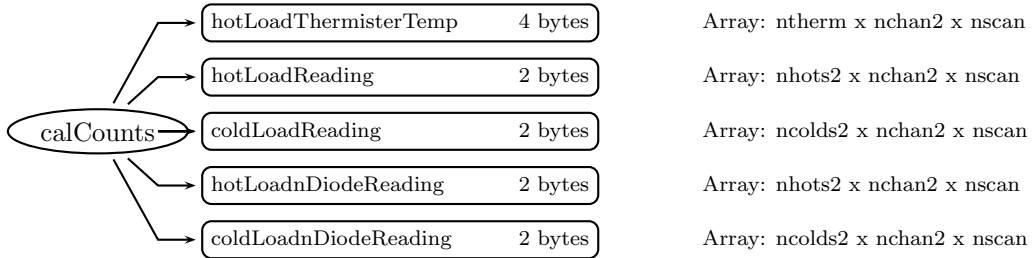


Figure 16: Data Format Structure for 1BGMI, S2, calCounts

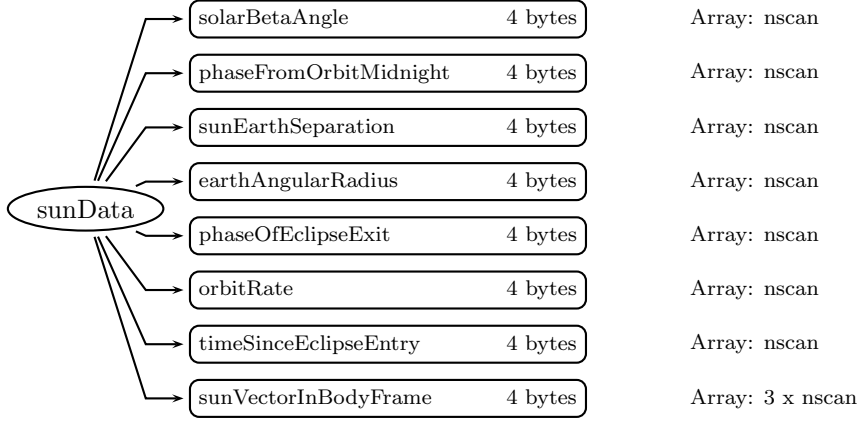


Figure 17: Data Format Structure for 1BGMI, S2, sunData

Hour (1-byte integer, array size: nscan):

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):

Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):

Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):

A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix1 x nscan):

The earth latitude of the center of the IFOV at the altitude of the earth ellipsoid. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix1 x nscan):

The earth longitude of the center of the IFOV at the altitude of the earth ellipsoid. Longitude is positive east, negative west. A point on the 180th meridian has the value

-180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S1)

dataQuality (1-byte integer, array size: nscan):

A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0, the unsigned integer value is 2^i).

Bit	Meaning if bit = 1
0	missing
5	geoError is not zero
6	modeStatus is not zero

missing (1-byte integer, array size: nscan):

Indicates whether information is contained in the scan data. The values are:

Bit	Meaning if bit = 1
0	Scan is missing
1	Science telemetry packet missing
2	Science telemetry segment withing packet missing
3	Science telemetry other missing
4	Housekeeping (HK) telemetry packet missing
5	Spare (always 0)
6	Spare (always 0)
7	Spare (always 0)

modeStatus (1-byte integer, array size: nscan):

A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0, the unsigned integer value is 2^i). The non-routine situations follow:

Bit	Meaning if bit = 1
0	Spare (always 0)
1	SCorientation not 0 or 180
2	pointingStatus not 0
3	Spare (always 0)
4	Non-routine operationalMode
5	Spare (always 0)
6	Spare (always 0)
7	Spare (always 0)

geoError (2-byte integer, array size: nscan):

A summary of geolocation errors in the scan. `geoError` is used to set a bit in `dataQuality`. A zero integer value of `geoError` indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0 the unsigned integer value is 2^{*i}).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

Bit Meaning if bit = 1

- 0 Latitude limit exceeded for viewed pixel locations
- 1 Negative scan time, invalid input
- 2 Error getting spacecraft attitude at scan mid-time
- 3 Error getting spacecraft ephemeris at scan mid-time
- 4 Invalid input non-unit ray vector for any pixel
- 5 Ray misses Earth for any pixel with normal pointing
- 6 Nadir calculation error for subsatellite position
- 7 Pixel count with geolocation error over threshold
- 8 Error in getting spacecraft attitude for any pixel
- 9 Error in getting spacecraft ephemeris for any pixel
- 10 Spare (always 0)
- 11 Spare (always 0)
- 12 Spare (always 0)
- 13 Spare (always 0)
- 14 Spare (always 0)
- 15 Spare (always 0)

geoWarning (2-byte integer, array size: nscan):

A summary of geolocation warnings in the scan. `geoWarning` does not set a bit in `dataQuality`. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0 the unsigned integer value is 2^{*i}):

Bit Meaning if bit = 1

- 0 Ephemeris Gap Interpolated *
- 1 Attitude Gap Interpolated *
- 2 Attitude jump/discontinuity *
- 3 Attitude out of range *
- 4 Anomalous Time Step *

```

5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris *
9   Fallback to GEONS ephemeris *
10  Fallback to PVT ephemeris *
11  Fallback to OBP ephemeris *
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)

```

* Not implemented April 2012. Expected implementation Sept 2012

SCorientation (2-byte integer, array size: nscan):

The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

Value	Meaning
0	+X forward (yaw 0)
180	-X forward (yaw 180)
-8000	Non-nominal pointing
-9999	Missing

pointingStatus (2-byte integer, array size: nscan):

pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

Value	Meaning
0	Nominal pointing in Mission Science Mode
1	GPS point solution stale and PVT ephemeris used
2	GEONS solution stale and GEONS ephemeris used
-8000	Non-nominal mission science orientation
-9999	Missing

acsModeMidScan (1-byte integer, array size: nscan):

acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

Value	Meaning
0	LAUNCH

1	RATENULL
2	SUNPOINT
3	GSPM (Gyro-less Sun Point)
4	MSM (Mission Science Mode)
5	SLEW
6	DELTAH
7	DELTAV
-99	UNKNOWN -- ACS mode unavailable

targetSelectionMidScan (1-byte integer, array size: nscan):

targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

Value	Meaning
0	S/C Z axis nadir, +X in flight direction
1	Flight Z axis nadir, +X in flight direction
2	S/C Z axis nadir, -X in flight direction
3	Flight Z axis nadir, -X in flight direction
4	+90 yaw for DPR antenna pattern calibration
5	-90 yaw for DPR antenna pattern calibration
-99	Missing

operationalMode (1-byte integer, array size: nscan):

Status of the GMI instrument.

Bit	Meaning if bit = 1
0	Receiver status (0=ON, 1=OFF)
1	Spinup Status (0=ON, 1=OFF)

FractionalGranuleNumber (8-byte float, array size: nscan):

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

sampleHeader (Group in S1)

blanking (1-byte integer, array size: nscan):

Value of 0 = Table 0 used for hot and cold samples,
No blanking

Value of 1 = Table 1 used for hot and cold samples,

Blanking on both sides
Value of 2 = Table 2 used for hot and cold samples,
Blanking on begin side
Value of 3 = Table 3 used for hot and cold samples,
Blanking on end side

earthViewFirstSample (2-byte integer, array size: nscan):

Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan1 x nscan):

Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):

Tachometer seconds. Special values are defined as:

0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):

Tachometer microseconds. Special values are defined as:

0 Missing value

navigation (Group in S1)

scPos (4-byte float, array size: XYZ x nscan):

The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:

-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):

The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:

-9999.9 Missing value

scLat (4-byte float, array size: nscan):

The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:

-9999.9 Missing value

scLon (4-byte float, array size: nscan):

The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAlt (4-byte float, array size: nscan):

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time. Values

range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):

The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):

The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):

The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):

The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 390 degrees. Special values are defined as:

-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):

The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC, 6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:

-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):

Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:

-9999.9 Missing value

calibration (Group in S1)

hotLoadTemp (4-byte float, array size: nchan1 x nscan):

The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan1 x nscan):

The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan1 x nscan):

The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan1 x nscan):

The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan1 x nscan):

The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan1 x nscan):
The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:

65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan1 x nscan):
The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan1 x nscan):
Automatic gain control. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan1 x nscan):
Offset. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan1 x nscan):
The nonlinear gain. Special values are defined as:

-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):
calibrationQCflag. Values range from 0 to 15. Special values are defined as:

-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):
Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use Load-Reading Values range from 0 to 1 counts. Special values are defined as:

-9999 Missing value

receiverTemp (4-byte float, array size: nchan1 x nscan):
The receiver temperature. Special values are defined as:

-9999.9 Missing value

receiverGain (4-byte float, array size: nchan1 x nscan):
The receiver gain. Special values are defined as:

-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):
The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:

-9999.9 Missing value

calCounts (Group in S1)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan1 x nscan):

Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):

Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):

Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots1 x nchan1 x nscan):

Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds1 x nchan1 x nscan):

Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

sunData (Group in S1)

solarBetaAngle (4-byte float, array size: nscan):

Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:

-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):

Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:

-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):

The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:

-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):

The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:

-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):

The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:

-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):

The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:

-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):

The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:

-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):

The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:

-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix1 x nscan):

The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsoid. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix1 x nscan):

The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix1 x nscan):

The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix1 x nscan):

The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix1 x nscan):

Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsoid-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Tb (4-byte float, array size: nchan1 x npix1 x nscan):

Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

S2 (Swath)

S2_SwathHeader (Metadata):

SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for GPM Products for details.

ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan):

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan):

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan):

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan):

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan):

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan):

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):

Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

SecondOfDay (8-byte float, array size: nscan):

A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

Latitude (4-byte float, array size: npix2 x nscan):

The earth latitude of the center of the IFOV at the altitude of the earth ellipsoid. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npix2 x nscan):

The earth longitude of the center of the IFOV at the altitude of the earth ellipsoid. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group in S2)

dataQuality (1-byte integer, array size: nscan):

A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0, the unsigned integer value is 2^i).

Bit	Meaning if bit = 1
0	missing
5	geoError is not zero
6	modeStatus is not zero

missing (1-byte integer, array size: nscan):

Indicates whether information is contained in the scan data. The values are:

Bit	Meaning if bit = 1
0	Scan is missing
1	Science telemetry packet missing
2	Science telemetry segment withing packet missing
3	Science telemetry other missing
4	Housekeeping (HK) telemetry packet missing
5	Spare (always 0)

- 6 Spare (always 0)
- 7 Spare (always 0)

modeStatus (1-byte integer, array size: nscan):

A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0, the unsigned integer value is 2^{*i}). The non-routine situations follow:

- Bit Meaning if bit = 1
- 0 Spare (always 0)
 - 1 SCorientation not 0 or 180
 - 2 pointingStatus not 0
 - 3 Spare (always 0)
 - 4 Non-routine operationalMode
 - 5 Spare (always 0)
 - 6 Spare (always 0)
 - 7 Spare (always 0)

geoError (2-byte integer, array size: nscan):

A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0 the unsigned integer value is 2^{*i}).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

- Bit Meaning if bit = 1
- 0 Latitude limit exceeded for viewed pixel locations
 - 1 Negative scan time, invalid input
 - 2 Error getting spacecraft attitude at scan mid-time
 - 3 Error getting spacecraft ephemeris at scan mid-time
 - 4 Invalid input non-unit ray vector for any pixel
 - 5 Ray misses Earth for any pixel with normal pointing
 - 6 Nadir calculation error for subsatellite position
 - 7 Pixel count with geolocation error over threshold
 - 8 Error in getting spacecraft attitude for any pixel
 - 9 Error in getting spacecraft ephemeris for any pixel

- 10 Spare (always 0)
- 11 Spare (always 0)
- 12 Spare (always 0)
- 13 Spare (always 0)
- 14 Spare (always 0)
- 15 Spare (always 0)

geoWarning (2-byte integer, array size: nscan):

A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit $i = 1$ and other bits = 0 the unsigned integer value is 2^i):

- | Bit | Meaning if bit = 1 |
|-----|--|
| 0 | Ephemeris Gap Interpolated * |
| 1 | Attitude Gap Interpolated * |
| 2 | Attitude jump/discontinuity * |
| 3 | Attitude out of range * |
| 4 | Anomalous Time Step * |
| 5 | GHA not calculated due to error |
| 6 | SunData (Group) not calculated due to error |
| 7 | Failure to calculate Sun in inertial coordinates |
| 8 | Fallback to GES ephemeris * |
| 9 | Fallback to GEONS ephemeris * |
| 10 | Fallback to PVT ephemeris * |
| 11 | Fallback to OBP ephemeris * |
| 12 | Spare (always 0) |
| 13 | Spare (always 0) |
| 14 | Spare (always 0) |
| 15 | Spare (always 0) |

* Not implemented April 2012. Expected implementation Sept 2012

SCorientation (2-byte integer, array size: nscan):

The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

- | Value | Meaning |
|-------|----------------------|
| 0 | +X forward (yaw 0) |
| 180 | -X forward (yaw 180) |

-8000 Non-nominal pointing
-9999 Missing

pointingStatus (2-byte integer, array size: nscan):

pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

Value	Meaning
0	Nominal pointing in Mission Science Mode
1	GPS point solution stale and PVT ephemeris used
2	GEONS solution stale and GEONS ephemeris used
-8000	Non-nominal mission science orientation
-9999	Missing

acsModeMidScan (1-byte integer, array size: nscan):

acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

Value	Meaning
0	LAUNCH
1	RATENULL
2	SUNPOINT
3	GSPM (Gyro-less Sun Point)
4	MSM (Mission Science Mode)
5	SLEW
6	DELTAH
7	DELTAV
-99	UNKNOWN -- ACS mode unavailable

targetSelectionMidScan (1-byte integer, array size: nscan):

targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

Value	Meaning
0	S/C Z axis nadir, +X in flight direction
1	Flight Z axis nadir, +X in flight direction
2	S/C Z axis nadir, -X in flight direction
3	Flight Z axis nadir, -X in flight direction
4	+90 yaw for DPR antenna pattern calibration
5	-90 yaw for DPR antenna pattern calibration
-99	Missing

operationalMode (1-byte integer, array size: nscan):

Status of the GMI instrument.

Bit	Meaning if bit = 1
0	Receiver status (0=ON, 1=OFF)
1	Spinup Status (0=ON, 1=OFF)

FractionalGranuleNumber (8-byte float, array size: nscan):

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

sampleHeader (Group in S2)

blanking (1-byte integer, array size: nscan):

Value of 0	= Table 0 used for hot and cold samples, No blanking
Value of 1	= Table 1 used for hot and cold samples, Blanking on both sides
Value of 2	= Table 2 used for hot and cold samples, Blanking on begin side
Value of 3	= Table 3 used for hot and cold samples, Blanking on end side

earthViewFirstSample (2-byte integer, array size: nscan):

Sample number of the first earth view. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

sampleNumber (2-byte integer, array size: nsamt x nchan2 x nscan):

Number of valid samples in scan. Values range from 0 to 512. Special values are defined as:

-9999 Missing value

tachSeconds (4-byte unsigned integer, array size: ntach x nscan):

Tachometer seconds. Special values are defined as:

0 Missing value

tachMicroSeconds (2-byte unsigned integer, array size: ntach x nscan):

Tachometer microseconds. Special values are defined as:

0 Missing value

navigation (Group in S2)

scPos (4-byte float, array size: XYZ x nscan):

The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:

-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):

The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:

-9999.9 Missing value

scLat (4-byte float, array size: nscan):

The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:

-9999.9 Missing value

scLon (4-byte float, array size: nscan):

The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAlt (4-byte float, array size: nscan):

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

dprAlt (4-byte float, array size: nscan):

The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time from DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:

-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):

The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):

The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):

The geodetic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):

The geodetic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:

-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):

The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 390 degrees. Special values are defined as:

-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):

The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC, 6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:

-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):

Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:

-9999.9 Missing value

calibration (Group in S2)

hotLoadTemp (4-byte float, array size: nchan2 x nscan):

The mean physical temperature for the temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

coldSkyTemp (4-byte float, array size: nchan2 x nscan):

The mean cold sky temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

onOrbitNonLinearity (4-byte float, array size: nchan2 x nscan):

The on Orbit Non-Linearity. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

derivedNonLinearity (4-byte float, array size: nchan2 x nscan):

The derived Non-Linearity. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

meanHotLoadCount (2-byte unsigned integer, array size: nchan2 x nscan):

The mean Hot Load Count. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanHotLoadCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):

The mean Hot Load Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanColdSkyCount (2-byte unsigned integer, array size: nchan2 x nscan):

The mean Cold Sky Count. Values range from 0 to 15. Special values are defined as:

65535 Missing value

meanColdSkyCntnDiode (2-byte unsigned integer, array size: nchan2 x nscan):

The mean Cold Sky Count Plus Noise Diode. Values range from 0 to 15. Special values are defined as:

65535 Missing value

diodeCoupledTemp (4-byte float, array size: nchan2 x nscan):

The diode Coupled Temp. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

gain (4-byte float, array size: LNL x nchan2 x nscan):

Automatic gain control. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

offset (4-byte float, array size: LNL x nchan2 x nscan):

Offset. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

nonLinearGain (4-byte float, array size: nchan2 x nscan):

The nonlinear gain. Special values are defined as:

-9999.9 Missing value

calibrationQCflag (2-byte integer, array size: nscan):

calibrationQCflag. Values range from 0 to 15. Special values are defined as:

-9999 Missing value

diodeFlag (2-byte integer, array size: nscan):

Diode flag. If diodeFlag = 1, use LoadPlusDiodeReading If diodeFlag = 0, use Load-Reading Values range from 0 to 1 counts. Special values are defined as:

-9999 Missing value

receiverTemp (4-byte float, array size: nchan2 x nscan):

The receiver temperature. Special values are defined as:

-9999.9 Missing value

receiverGain (4-byte float, array size: nchan2 x nscan):

The receiver gain. Special values are defined as:

-9999.9 Missing value

moonVectorInstFrame (4-byte float, array size: GMIxyz x nscan):

The x, y, z components of the moon vector in the GMI instrument coordinate system. Values are in counts. Special values are defined as:

-9999.9 Missing value

calCounts (Group in S2)

hotLoadThermisterTemp (4-byte float, array size: ntherm x nchan2 x nscan):

Hot Load Thermister Temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

hotLoadReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):

Hot Load Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

coldLoadReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):

Cold Load Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

hotLoadnDiodeReading (2-byte unsigned integer, array size: nhots2 x nchan2 x nscan):

Hot Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are defined as:

0 Missing value

coldLoadnDiodeReading (2-byte unsigned integer, array size: ncolds2 x nchan2 x nscan):

Cold Load Plus Diode Reading. Values range from 0 to 15 counts. Special values are

defined as:

0 Missing value

sunData (Group in S2)

solarBetaAngle (4-byte float, array size: nscan):

Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -89.0 to 89.0 degrees. Special values are defined as:

-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):

Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:

-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):

The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:

-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):

The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:

-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):

The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 0.0 to 80.0 degrees. Special values are defined as:

-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):

The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:

-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):

The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:

-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):

The unit sun vector direction in the TMI instrument body coordinate frame, defined such

that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:

-9999.9 Missing value

incidenceAngle (4-byte float, array size: npix2 x nscan):

The angle at the center of the IFOV between the antenna boresight vector and the zenith vector normal to the Earth Ellipsoid. Also known as Satellite Zenith Angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

satAzimuthAngle (4-byte float, array size: npix2 x nscan):

The angle clockwise looking down between the local pixel geodetic north and the direction to the satellite. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

solarZenAngle (4-byte float, array size: npix2 x nscan):

The angle between the local pixel geodetic zenith and the direction to the sun. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

solarAzimuthAngle (4-byte float, array size: npix2 x nscan):

The angle clockwise looking down between the local pixel geodetic north and the direction to the sun. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

sunGlintAngle (4-byte float, array size: npix2 x nscan):

Conceptually, the angle between the sun and the instrument view direction as reflected off the Earth's surface. More specifically, define a Sun Vector from the viewed pixel location on the earth ellipsoid-model surface to the sun. Also define an Inverse Satellite Vector from the pixel to the satellite. Then reflect the Inverse Satellite Vector off the earth's surface at the pixel location to form the Reflected Satellite View Vector. sunGlintAngle is the angular separation between the Reflected Satellite View Vector and the Sun Vector. When sunGlintAngle is zero, the instrument views the center of the specular (mirror-like) sun reflection. Values range from 0 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Tb (4-byte float, array size: nchan2 x npix2 x nscan):

Earth view brightness temperature. Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

C Structure Header file:

```
#ifndef _TK_1BGMI_H_
#define _TK_1BGMI_H_

#ifdef _L1BGMI_S2_SUNDATA_
```

```

#define _L1BGMI_S2_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S2_SUNDATA;

#endif

#ifndef _L1BGMI_S2_CALCOUNTS_
#define _L1BGMI_S2_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[4][11];
    unsigned short hotLoadReading[4][33];
    unsigned short coldLoadReading[4][51];
    unsigned short hotLoadnDiodeReading[4][33];
    unsigned short coldLoadnDiodeReading[4][51];
} L1BGMI_S2_CALCOUNTS;

#endif

#ifndef _L1BGMI_S2_CALIBRATION_
#define _L1BGMI_S2_CALIBRATION_

typedef struct {
    float hotLoadTemp[4];
    float coldSkyTemp[4];
    float onOrbitNonLinearity[4];
    float derivedNonLinearity[4];
    unsigned short meanHotLoadCount[4];
    unsigned short meanHotLoadCntnDiode[4];
    unsigned short meanColdSkyCount[4];
    unsigned short meanColdSkyCntnDiode[4];
    float diodeCoupledTemp[4];
    float gain[4][2];
    float offset[4][2];
}

```

```

        float nonLinearGain[4];
        short calibrationQCflag;
        short diodeFlag;
        float receiverTemp[4];
        float receiverGain[4];
    } L1BGMI_S2_CALIBRATION;

#endif

#ifndef _L1BGMI_S2_SAMPLEHEADER_
#define _L1BGMI_S2_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[4][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
} L1BGMI_S2_SAMPLEHEADER;

#endif

#ifndef _L1BGMI_S2_SCANSTATUS_
#define _L1BGMI_S2_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S2_SCANSTATUS;

#endif

#ifndef _L1BGMI_S2_
#define _L1BGMI_S2_

```

```

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1BGMI_S2_SCANSTATUS scanStatus;
    L1BGMI_S2_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    L1BGMI_S2_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S2_CALCOUNTS calCounts;
    L1BGMI_S2_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][4];
} L1BGMI_S2;

#endif

#ifndef _L1BGMI_S1_SUNDATA_
#define _L1BGMI_S1_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1BGMI_S1_SUNDATA;

#endif

#ifndef _L1BGMI_S1_CALCOUNTS_
#define _L1BGMI_S1_CALCOUNTS_

typedef struct {
    float hotLoadThermisterTemp[9][11];

```

```

        unsigned short hotLoadReading[9][33];
        unsigned short coldLoadReading[9][51];
        unsigned short hotLoadnDiodeReading[9][33];
        unsigned short coldLoadnDiodeReading[9][51];
    } L1BGMI_S1_CALCOUNTS;

```

```

#endif

```

```

#ifndef _L1BGMI_S1_CALIBRATION_
#define _L1BGMI_S1_CALIBRATION_

```

```

typedef struct {
    float hotLoadTemp[9];
    float coldSkyTemp[9];
    float onOrbitNonLinearity[9];
    float derivedNonLinearity[9];
    unsigned short meanHotLoadCount[9];
    unsigned short meanHotLoadCntnDiode[9];
    unsigned short meanColdSkyCount[9];
    unsigned short meanColdSkyCntnDiode[9];
    float diodeCoupledTemp[9];
    float gain[9][2];
    float offset[9][2];
    float nonLinearGain[9];
    short calibrationQCflag;
    short diodeFlag;
    float receiverTemp[9];
    float receiverGain[9];
} L1BGMI_S1_CALIBRATION;

```

```

#endif

```

```

#ifndef _NAVIGATION_
#define _NAVIGATION_

```

```

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;

```

```

        float scAttPitchGeoc;
        float scAttYawGeoc;
        float scAttRollGeod;
        float scAttPitchGeod;
        float scAttYawGeod;
        float greenHourAng;
        double timeMidScan;
        double timeMidScanOffset;
    } NAVIGATION;

#endif

#ifndef _L1BGMI_S1_SAMPLEHEADER_
#define _L1BGMI_S1_SAMPLEHEADER_

typedef struct {
    signed char blanking;
    short earthViewFirstSample;
    short sampleNumber[9][4];
    unsigned int tachSeconds[32];
    unsigned short tachMicroSeconds[32];
} L1BGMI_S1_SAMPLEHEADER;

#endif

#ifndef _L1BGMI_S1_SCANSTATUS_
#define _L1BGMI_S1_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    double FractionalGranuleNumber;
} L1BGMI_S1_SCANSTATUS;

#endif

```



```

#ifndef _SCANTIME_
#define _SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
    double SecondOfDay;
} SCANTIME;

#endif

#ifndef _L1BGMI_S1_
#define _L1BGMI_S1_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[221];
    float Longitude[221];
    L1BGMI_S1_SCANSTATUS scanStatus;
    L1BGMI_S1_SAMPLEHEADER sampleHeader;
    NAVIGATION navigation;
    L1BGMI_S1_CALIBRATION calibration;
    float moonVectorInstFrame[3];
    L1BGMI_S1_CALCOUNTS calCounts;
    L1BGMI_S1_SUNDATA sunData;
    float incidenceAngle[221];
    float satAzimuthAngle[221];
    float solarZenAngle[221];
    float solarAzimuthAngle[221];
    float sunGlintAngle[221];
    float Tb[221][9];
} L1BGMI_S1;

#endif

#ifndef _L1BGMI_SWATHS_

```

```
#define _L1BGMI_SWATHS_
```

```
typedef struct {  
    L1BGMI_S1 S1;  
    L1BGMI_S2 S2;  
} L1BGMI_SWATHS;
```

```
#endif
```

```
#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1BGMI_S2_SUNDATA/  
    REAL*4 solarBetaAngle  
    REAL*4 phaseFromOrbitMidnight  
    REAL*4 sunEarthSeparation  
    REAL*4 earthAngularRadius  
    REAL*4 phaseOfEclipseExit  
    REAL*4 orbitRate  
    REAL*4 timeSinceEclipseEntry  
    REAL*4 sunVectorInBodyFrame(3)  
END STRUCTURE
```

```
STRUCTURE /L1BGMI_S2_CALCOUNTS/  
    REAL*4 hotLoadThermisterTemp(11,4)  
    INTEGER*2 hotLoadReading(33,4)  
    INTEGER*2 coldLoadReading(51,4)  
    INTEGER*2 hotLoadnDiodeReading(33,4)  
    INTEGER*2 coldLoadnDiodeReading(51,4)  
END STRUCTURE
```

```
STRUCTURE /L1BGMI_S2_CALIBRATION/  
    REAL*4 hotLoadTemp(4)  
    REAL*4 coldSkyTemp(4)  
    REAL*4 onOrbitNonLinearity(4)  
    REAL*4 derivedNonLinearity(4)  
    INTEGER*2 meanHotLoadCount(4)  
    INTEGER*2 meanHotLoadCntnDiode(4)  
    INTEGER*2 meanColdSkyCount(4)  
    INTEGER*2 meanColdSkyCntnDiode(4)  
    REAL*4 diodeCoupledTemp(4)  
    REAL*4 gain(2,4)
```

```

    REAL*4 offset(2,4)
    REAL*4 nonLinearGain(4)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(4)
    REAL*4 receiverGain(4)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SAMPLEHEADER/
    BYTE blanking
    INTEGER*2 earthViewFirstSample
    INTEGER*2 sampleNumber(4,4)
    INTEGER*4 tachSeconds(32)
    INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S2_SCANSTATUS/
    BYTE dataQuality
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1BGMI_S2/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1BGMI_S2_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S2_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S2_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BGMI_S2_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S2_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)

```

```

    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlntAngle(221)
    REAL*4 Tb(4,221)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1BGMI_S1_CALCOUNTS/
    REAL*4 hotLoadThermisterTemp(11,9)
    INTEGER*2 hotLoadReading(33,9)
    INTEGER*2 coldLoadReading(51,9)
    INTEGER*2 hotLoadnDiodeReading(33,9)
    INTEGER*2 coldLoadnDiodeReading(51,9)
END STRUCTURE

STRUCTURE /L1BGMI_S1_CALIBRATION/
    REAL*4 hotLoadTemp(9)
    REAL*4 coldSkyTemp(9)
    REAL*4 onOrbitNonLinearity(9)
    REAL*4 derivedNonLinearity(9)
    INTEGER*2 meanHotLoadCount(9)
    INTEGER*2 meanHotLoadCntnDiode(9)
    INTEGER*2 meanColdSkyCount(9)
    INTEGER*2 meanColdSkyCntnDiode(9)
    REAL*4 diodeCoupledTemp(9)
    REAL*4 gain(2,9)
    REAL*4 offset(2,9)
    REAL*4 nonLinearGain(9)
    INTEGER*2 calibrationQCflag
    INTEGER*2 diodeFlag
    REAL*4 receiverTemp(9)
    REAL*4 receiverGain(9)
END STRUCTURE

```

```

STRUCTURE /NAVIGATION/
  REAL*4 scPos(3)
  REAL*4 scVel(3)
  REAL*4 scLat
  REAL*4 scLon
  REAL*4 scAlt
  REAL*4 dprAlt
  REAL*4 scAttRollGeoc
  REAL*4 scAttPitchGeoc
  REAL*4 scAttYawGeoc
  REAL*4 scAttRollGeod
  REAL*4 scAttPitchGeod
  REAL*4 scAttYawGeod
  REAL*4 greenHourAng
  REAL*8 timeMidScan
  REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L1BGMI_S1_SAMPLEHEADER/
  BYTE blanking
  INTEGER*2 earthViewFirstSample
  INTEGER*2 sampleNumber(4,9)
  INTEGER*4 tachSeconds(32)
  INTEGER*2 tachMicroSeconds(32)
END STRUCTURE

STRUCTURE /L1BGMI_S1_SCANSTATUS/
  BYTE dataQuality
  BYTE missing
  BYTE modeStatus
  INTEGER*2 geoError
  INTEGER*2 geoWarning
  INTEGER*2 SCorientation
  INTEGER*2 pointingStatus
  BYTE acsModeMidScan
  BYTE targetSelectionMidScan
  BYTE operationalMode
  REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
  INTEGER*2 Year

```

```

    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L1BGMI_S1/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(221)
    REAL*4 Longitude(221)
    RECORD /L1BGMI_S1_SCANSTATUS/ scanStatus
    RECORD /L1BGMI_S1_SAMPLEHEADER/ sampleHeader
    RECORD /NAVIGATION/ navigation
    RECORD /L1BGMI_S1_CALIBRATION/ calibration
    REAL*4 moonVectorInstFrame(3)
    RECORD /L1BGMI_S1_CALCOUNTS/ calCounts
    RECORD /L1BGMI_S1_SUNDATA/ sunData
    REAL*4 incidenceAngle(221)
    REAL*4 satAzimuthAngle(221)
    REAL*4 solarZenAngle(221)
    REAL*4 solarAzimuthAngle(221)
    REAL*4 sunGlintAngle(221)
    REAL*4 Tb(9,221)
END STRUCTURE

STRUCTURE /L1BGMI_SWATHS/
    RECORD /L1BGMI_S1/ S1
    RECORD /L1BGMI_S2/ S2
END STRUCTURE

```